PCT/GB 00/02125

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Rec'd PCT/PTO 30 NOV 2001

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REC'D 28 JUN 2000
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Dated 19 June 2000

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Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
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1. Your reference AJC/JCB/573UK/43937/000

2. Patent application number *(The Patent Office will fill in this part)* 02 JUN 1999 9912681.5

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

WABCO AUTOMOTIVE U.K. LIMITED,
Beacon Works,
Texas Street,
Morley,
Leeds. LS27 0HQ

Patents ADP number *(if you know it)* 59517310 02 Rdes

If the applicant is a corporate body, give the country/state of its incorporation England

4. Title of the invention

VEHICLE AIR BRAKING SYSTEMS

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Withers & Rogers,
Goldings House,
2 Hays Lane,
London. SE1 2HW

Patents ADP number *(if you know it)* 00001776001 ✓

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

Yes

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	–
Description	4
Claim(s)	–
Abstract	–
Drawing(s)	1

10. If you are also filing any of the following, state how many against each item.

Priority documents	–
Translations of priority documents	–
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	–
Request for preliminary examination and search *(Patents Form 9/77)*	–
Request for substantive examination *(Patents Form 10/77)*	–
Any other documents *(please specify)*	–

11. I/We request the grant of a patent on the basis of this application.

Signature Withers & Rogers Date 01.06.99

12. Name and daytime telephone number of person to contact in the United Kingdom

Mr. A.J. Chettle
Tel: (01926) 336111

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Notes

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VEHICLE AIR BRAKING SYSTEMS

This invention relates to vehicle air braking systems, and particularly to electronic control of the air compressor for use in such systems.

A typical air braking system includes a compressor, a reservoir for pressurized air, a driver operated demand valve, and a plurality of air actuators for the vehicle wheel brakes. The system usually includes a dryer for compressor outlet air, and control means to take the compressor off load when the reservoir is at maximum pressure and the demand valve is closed. A compressor is typically taken off load by connecting the output temporarily to atmosphere, so that the compressor free wheels. Alternatively the compressor may include a clutch engageable with its drive source, usually the vehicle engine.

Compressors absorb significant energy, and accordingly it is desirable to minimize on-time whilst ensuring that a sufficient volume of pressurized air is available to meet demand. This is conventionally done by minimizing the 'dead' volume on the high pressure side of the demand valve. What is required is a control system which can better determine compressor on-time according to anticipated demand and the vehicle running state.

According to the invention there is provided an electronic control system for the compressor of a vehicle air braking system, the control system having a first input for indicating vehicle engine speed, a second input for indicating vehicle speed, a third input for indicating vehicle throttle opening, a fourth input for indicating air pressure in a reservoir downstream of the compressor, and an output for determining whether a compressor is on-load or off-load, the system further including means to calculate a target pressure for said reservoir, the target pressure being higher during throttle-off modes than during throttle-on modes.

In this specification the term 'throttle' is used in relation to the vehicle accelerator pedal or other means used to control admission of fuel to the vehicle engine.

Such a system requires a higher target pressure in throttle-off modes when the vehicle is likely to be coasting or slowing down. In such circumstances the fuel supply is normally

closed off by the driver releasing the accelerator pedal and accordingly vehicle momentum drives the engine and thus the compressor. The energy to drive the compressor in this mode is 'free', at least to the extent that fuel is not being burnt. Additional slowing of the vehicle occurs as a result of the compressor being on-load, but this may be useful where the throttle-off mode is accompanied by or followed by a braking event. In order to take maximum advantage during the throttle-off mode, the target pressure in the air reservoir can be raised above the normal level, and as a result compressor on-time during throttle-on modes can be reduced.

The invention permits a small but significant reduction in vehicle fuel consumption, and requires only minor adaptation of existing electronic control systems.

In a preferred embodiment the higher target pressure exceeds the normal target pressure by 8-10%. The system may include a third yet higher target pressure to meet high pressure requirements of associated air systems such as air suspension.

A particular advantage of the invention is that the higher target pressure exists during a braking (throttle-off) mode, and where this is the final braking event before the engine is stopped, the reservoir has an extra air charge to give a final purge of the usual air dryer. This is especially useful since the air braking system is left in a dry and clean state at the end of the working day. Also, the vehicle air system is clean and dry at the beginning of the next working day.

Preferably independent control of compressor and purge valve is provided. This ensures that the air line connecting the compressor and purge valve/reservoir is not exhausted each time the purge valve is actuated. Clearly if this air line is exhausted, as has hitherto been the case, the compressor is required to operate for a greater time when brought on load.

Other aspects of the invention will be apparent from the following description of a preferred embodiment shown by way of example only in the accompanying drawing which illustrates typical target pressures for a compressor in relation to vehicle operating modes.

In the drawing, the X axis indicates vehicle operating modes, whereas the Y axis indicates pressure. The target pressure is indicated by the narrow solid band. As shown on the drawing, a compressor idle state is indicated by a solid line, a dotted line indicates purging, and a dashed line indicates compressor pumping.

In a typical air braking system, the compressor output is directed via a non-return valve and air dryer to a reservoir. Periodically dry air from the reservoir is directed back through the air dryer (which typically includes a bed of desiccant material) in order to purge the majority of moisture therefrom. Purging may be controlled for example by a timer, and occurs after the compressor has been on-load for a predetermined period. Purging does not usually occur during the vehicle braking mode since the system permits air demand to override air quality; however braking events are usually short.

With reference to the drawing, the vehicle is shown first in the stopped mode; the engine is not running. Residual system pressure is low and the compressor is idle (in fact stopped). A target pressure is illustrated, but the value is not important.

Next the engine is started, and is idling. The pressure target is immediately set at the normal level; in this embodiment just above 9 bar. As illustrated, the compressor pumps in two stages with a timed purge in-between; the compressor may pump in more or less stages, as required. Other control systems prevent the vehicle being driven until a safe operating pressure is reached.

On reaching the target the compressor is brought off-load; system pressure may or may not decay, depending on leakage or use of air in systems such as air suspension or windscreen wiper operation.

The pressure target has the usual hysteresis to avoid continual switching of the compressor between on-load and off-load, and this is indicated by the width of the target pressure band.

During the driving mode the compressor will be brought on load as required, and purging events will also occur as necessary. The pressure target may oscillate slightly as indicated in the idling and driving modes to allow for purging events.

Next, in the overrun mode, the illustrated target pressure is increased to nearly 10 bar. The higher target pressure is set according to system requirements, and may be more or less than 10 bar. In this mode no fuel is used to drive the compressor. Pumping and purging events occur as previously explained. The same occurs in the braking mode, except that purging is avoided.

In the next idling mode the pressure target reduces again to the normal level. The compressor will not come on load again until reservoir pressure drops to the bottom of the normal level band. In this stage a purge cycle after braking is indicated - this is a normal event initiated by the control system to compensate for lack of purging during the braking event itself.

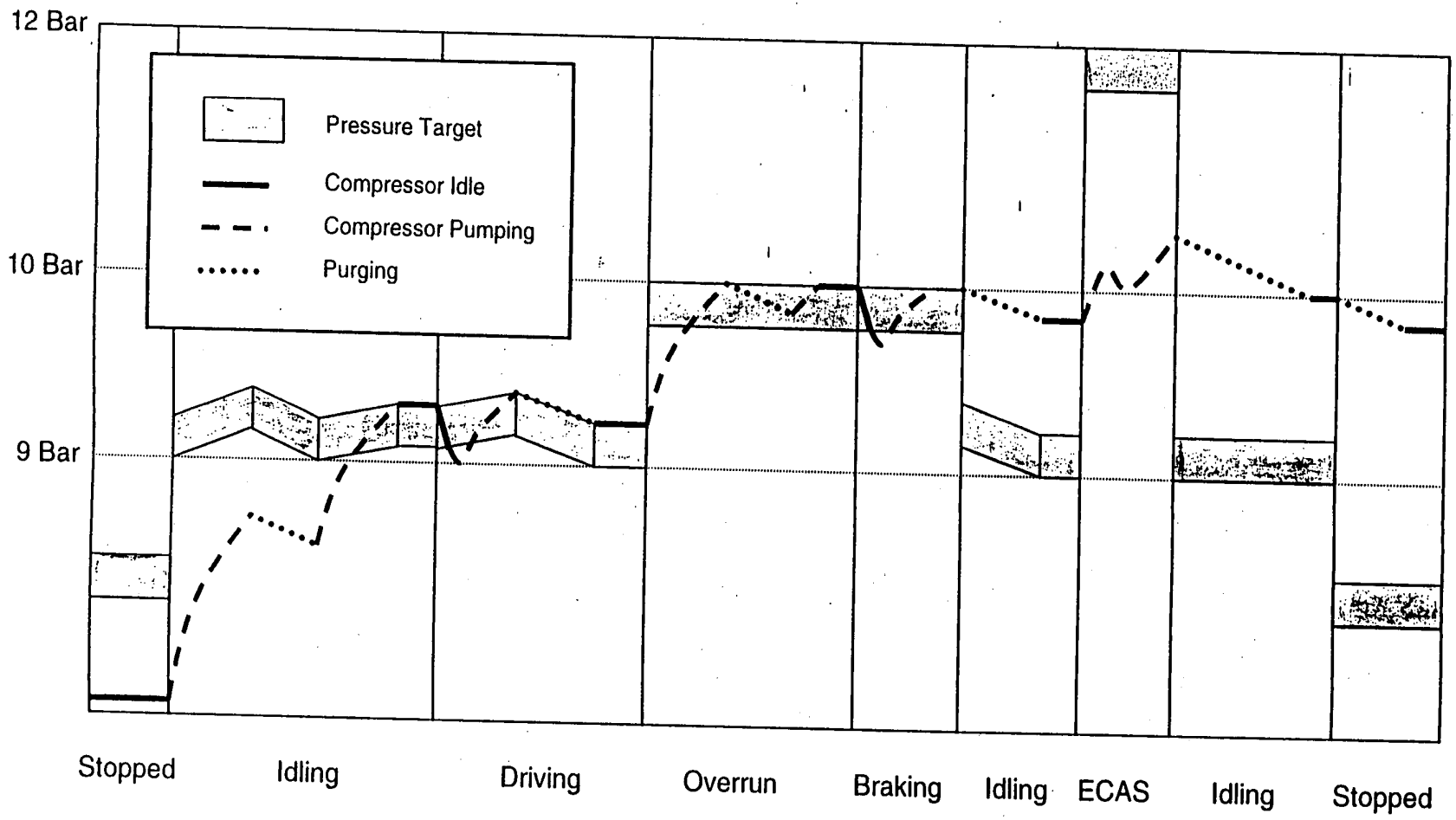
The lower pressure target would also occur in the event of another period in driving mode.

Next is illustrated an ECAS event. This occurs when an associated air system, for example vehicle air suspension requires a high pressure above the normal operating level. The compressor will attempt to reach the new target, but as illustrated, air consumption and supply are rather close and thus only a slight pressure increase is achieved before the ECAS event is terminated.

Next another idling mode is illustrated, and commenced by a purge cycle due to reduced purging during the ECAS event.

Finally the vehicle and engine are stopped. The target pressure drops to an unimportant minimum selected by the control software. The high residual pressure permits a final power-down purge to leave the inactive system clean and dry. A residual pressure remains in the system, and this is useful in preventing ingress of uncleaned and undried air.

This description illustrates a range of typical driving events, and is not intended to be exhaustive. The important feature is the higher pressure target during throttle off modes.


12 Bar
10 Bar
9 Bar
Pressure Target
Compressor Idle
Compressor Pumping
Purging
Stopped
Idling
Driving
Overrun
Braking
Idling
ECAS
Idling
Stopped
Vehicle State

PC/GB00/0.2125
F23177 2 June 2000.
Williams + Rogers.

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